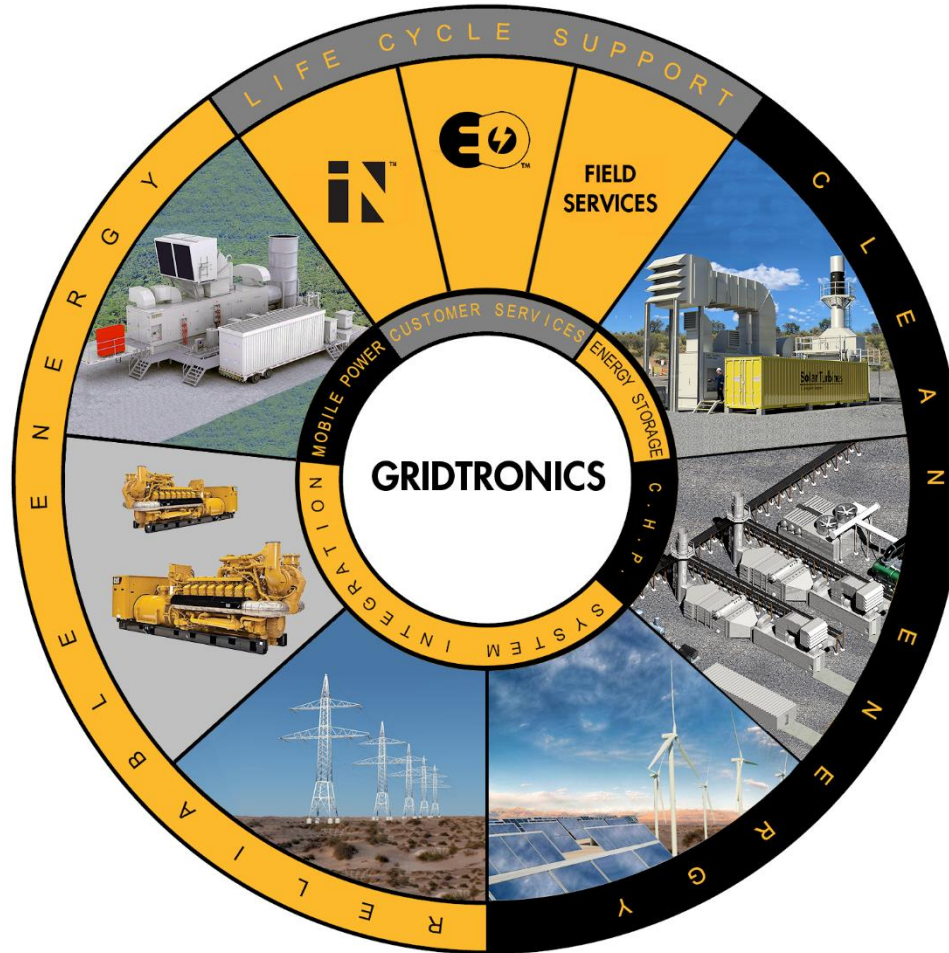


Gas Turbines in Microgrids

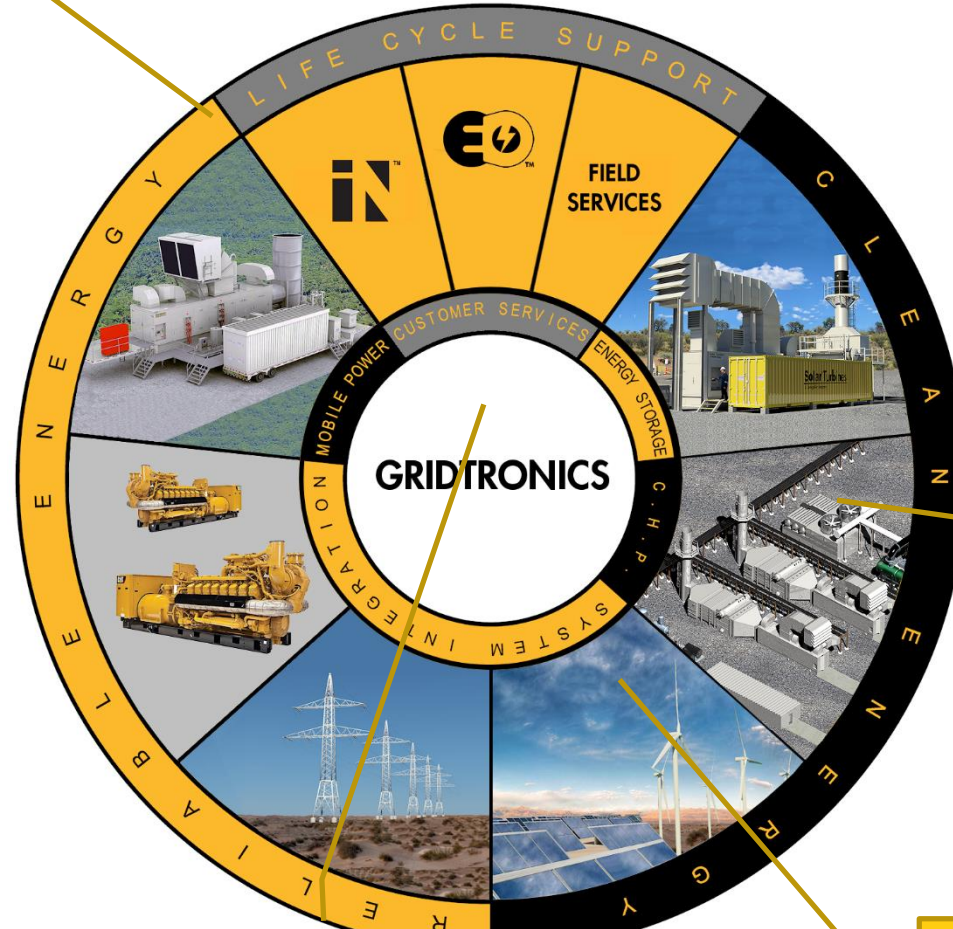
Daniel Fingleton, Microgrid Program Manager, Solar Turbines



AGENDA

Critical Power

Nuclear Power Station



CHP Plant

Guinness Energy Centre

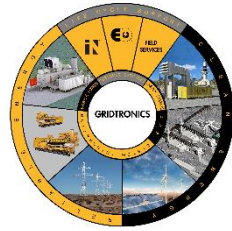
Power Management System

Microgrid Controller

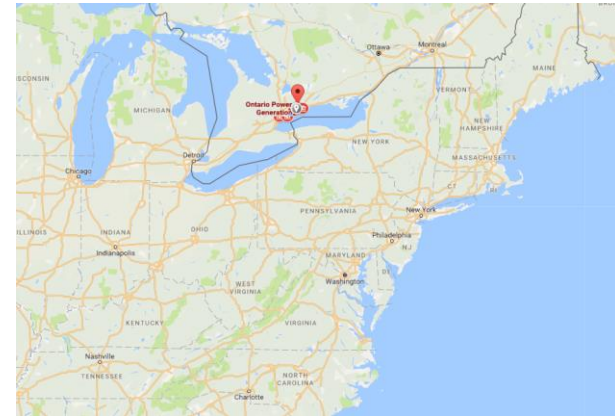
City of Esperance

Wind & GT Integration

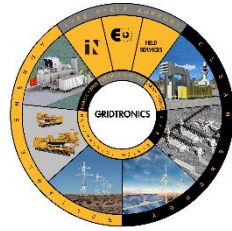
GT AS RELIABLE NUCLEAR POWER STATION



- Gas Turbines As the EPG
 - Prevent Nuclear Catastrophe
 - To remove decay heat and thus prevent subsequent process failure
 - To limit fission product release from containment.
 - To monitor the status of the nuclear steam supply system.
 - Third and Final Line of Defense
- Huge Reliability Requirement
 - Station cannot run if unavailable
 - Operate if earthquakes (seismic), tornados, rail car explosions, etc occur
- Fast Start Capability



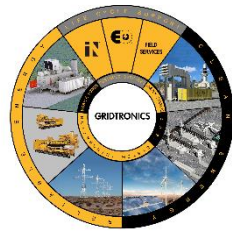
CONTROL PHILOSOPHY



- 1 of 3 units must be available at all time
 - If not available, entire station must be shutdown
- If called upon, they must run
 - Ability to inhibit any and all alarms
- Automatically synchronized to bus
 - Dead or Live Bus capability
 - Droop or ISOCH
- Has to meet all possible scenerios



RENEWABLE INTEGRATION - CITY OF ESPERANCE

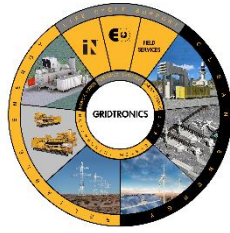


- Total Isolated Electrical Grid
- Ten Mile Lagoon Wind Farm
 - 9 x 225 KW Wind Turbine
 - Commissioned 1993
- Nine Mile Beach Wind Farm
 - 6 x 600 kW Wind Turbines
 - Commissioned 2003
- Esperance Energy Project
 - 7 x 5.5 MW Gas Turbines
 - Commissioned 2004

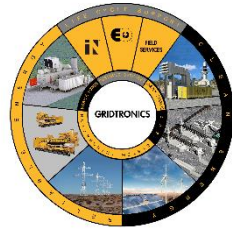


CONTROL PHILOSOPHY

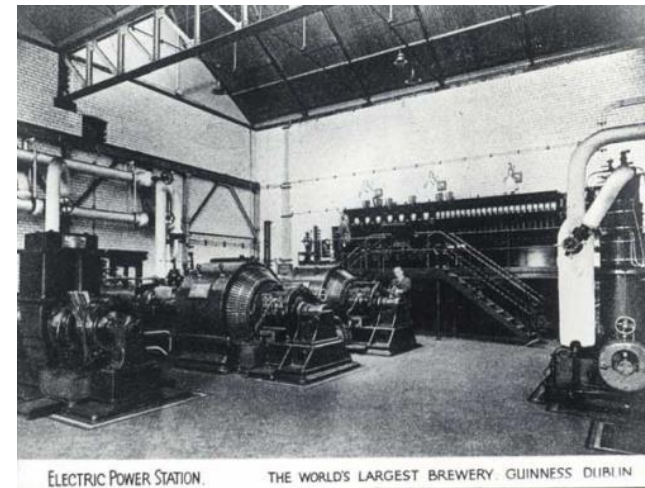
- Wind has top priority
 - No curtailment
- GT provide regulation
 - Voltage and Frequency
 - Rapid ability to increase/decrease load
- GT provides base load
 - Fewer units on at night time



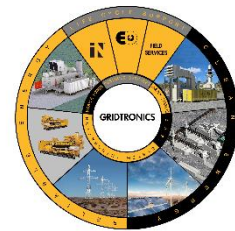
CHP - GUINNESS ENERGY CENTRE



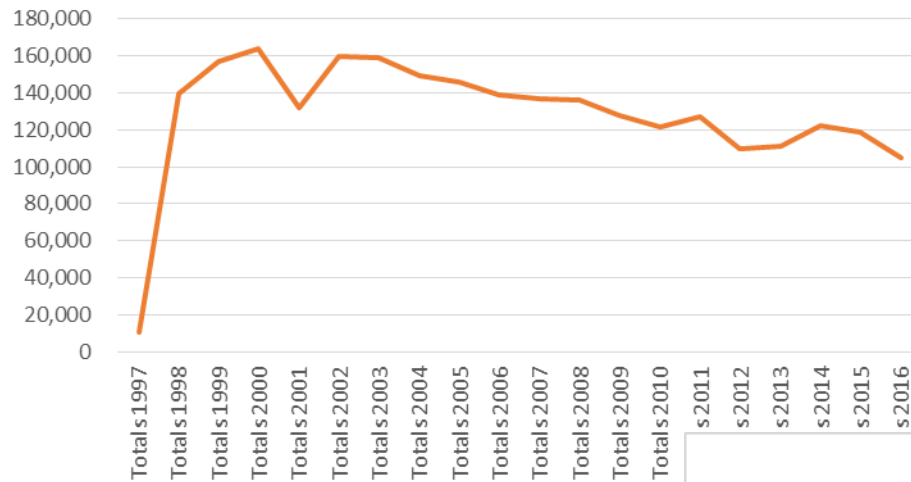
- **1809** - First Steam Engine
- **1883** - Burgin dynamo
- **1895** - two 60kw, 220 volt
 - Parson Steam Turbines
- **1948** - Power Station
 - 5 boilers
 - 3 Steam turbine alternators
- **1948** - Coal fired boilers
- **1966** - Changeover from Coal to Oil
- **1983** - Changeover from Oil to Natural Gas
- **1997** - Construction of independently owned Energy Centre
 - 3 x 4.7 MW Gas Turbines
 - 3 x 30t / per hour waste-heat Boilers
 - 1 x 30t / per hour fired Boiler
 - Black start capability



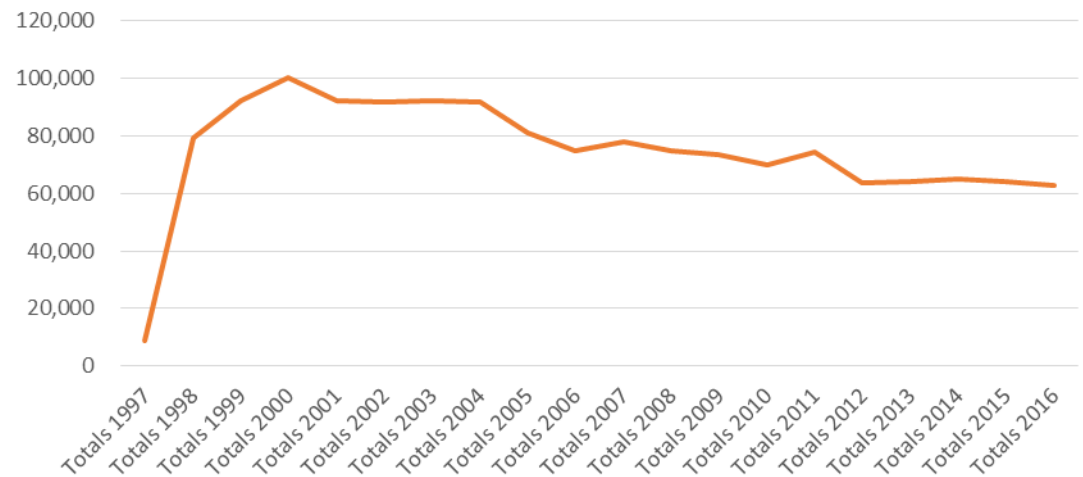
ENERGY DEMAND OVER TIME



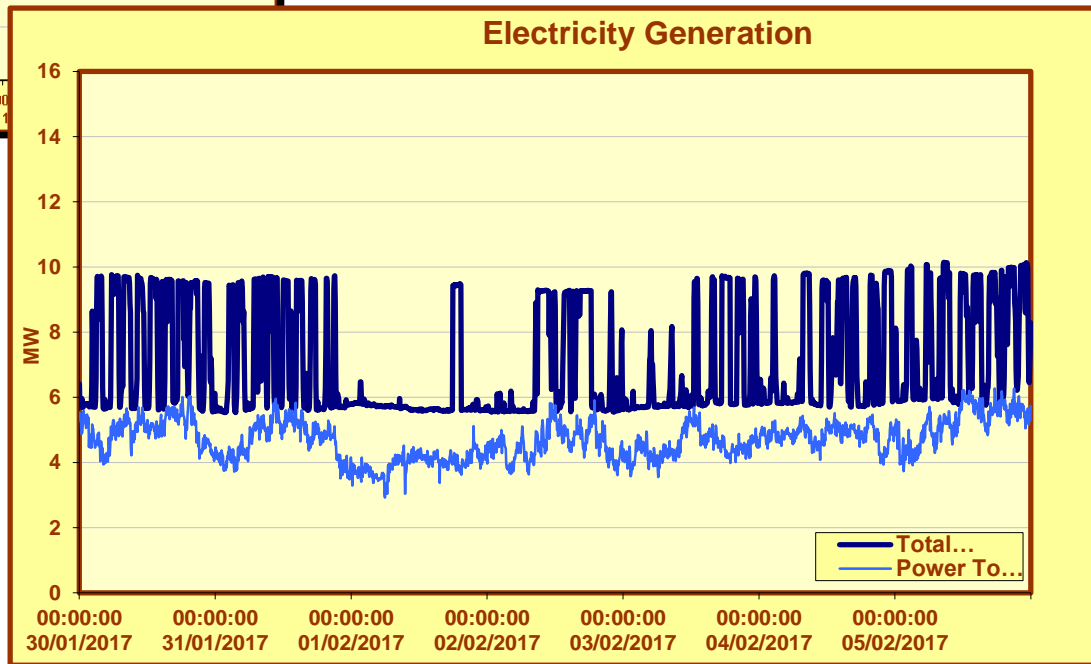
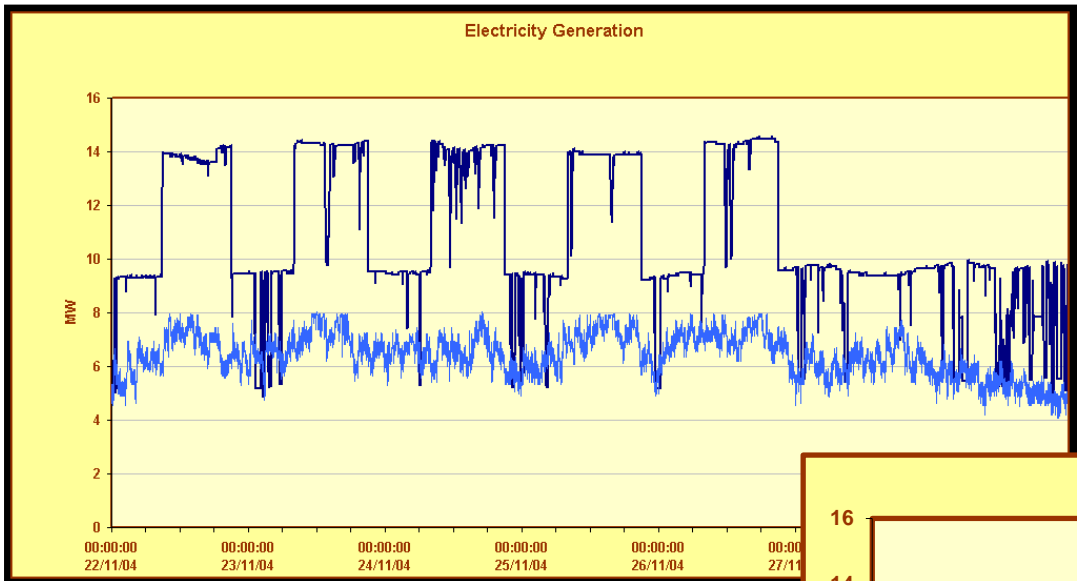
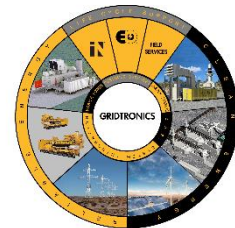
Steam Output



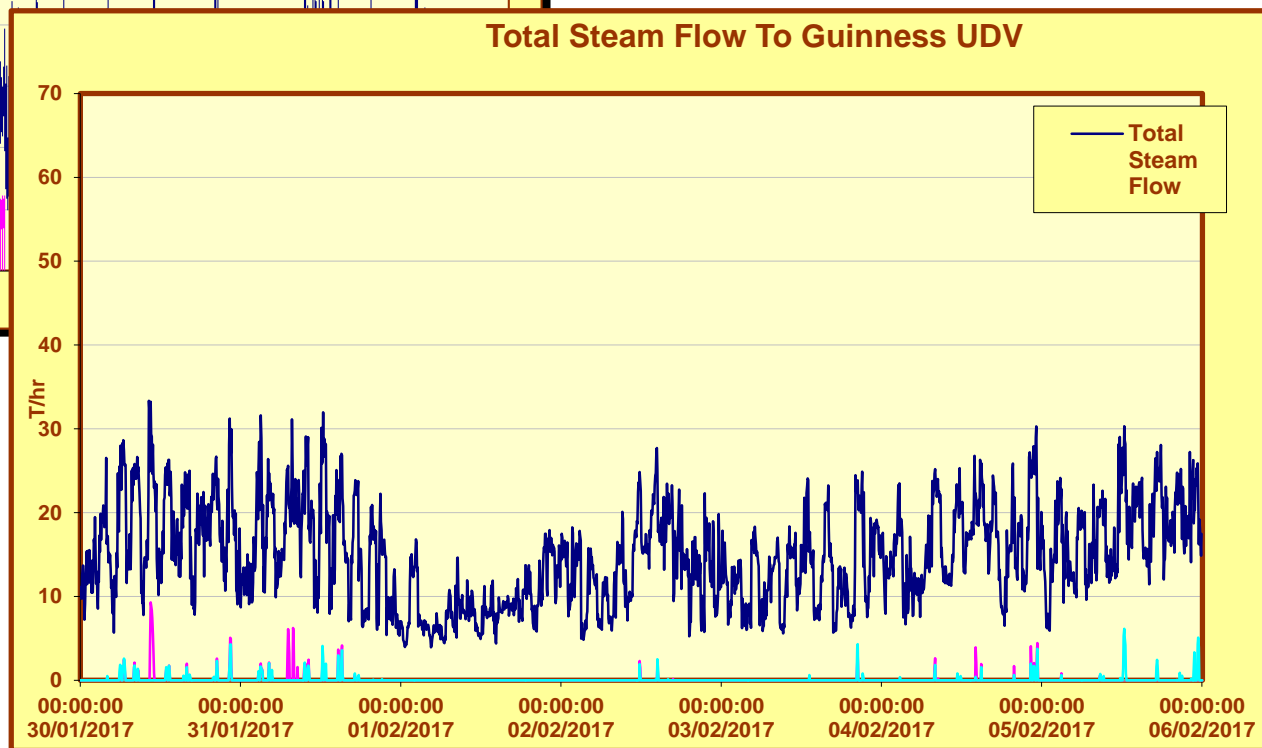
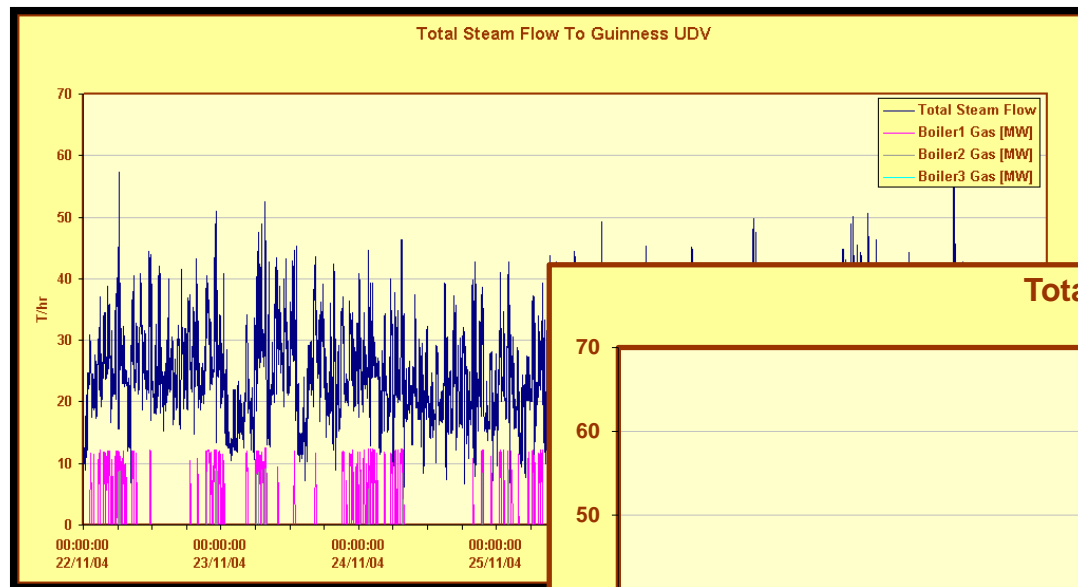
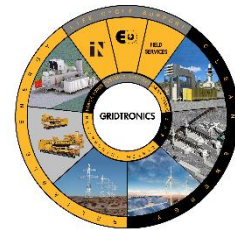
Total Electrical Output



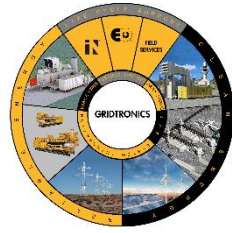
ELECTRICITY DEMAND PER HOUR



STEAM DEMAND PER HOUR



THE NEED FOR ELECTRICITY



- Resiliency of CHP
 - Islands 12 times a year pre 2015
- Always 2 units running @ 50%
 - Triple Redundancy
- Standby Boiler heated and available
- 2 Seconds of No Power
 - 12 Hrs Lost Production
 - Lost Product (aka Black Gold)
 - National News
 - Irish Biggest Tourist Attraction loses power



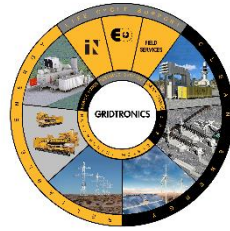
Aileen Donegan
@aileendonegan



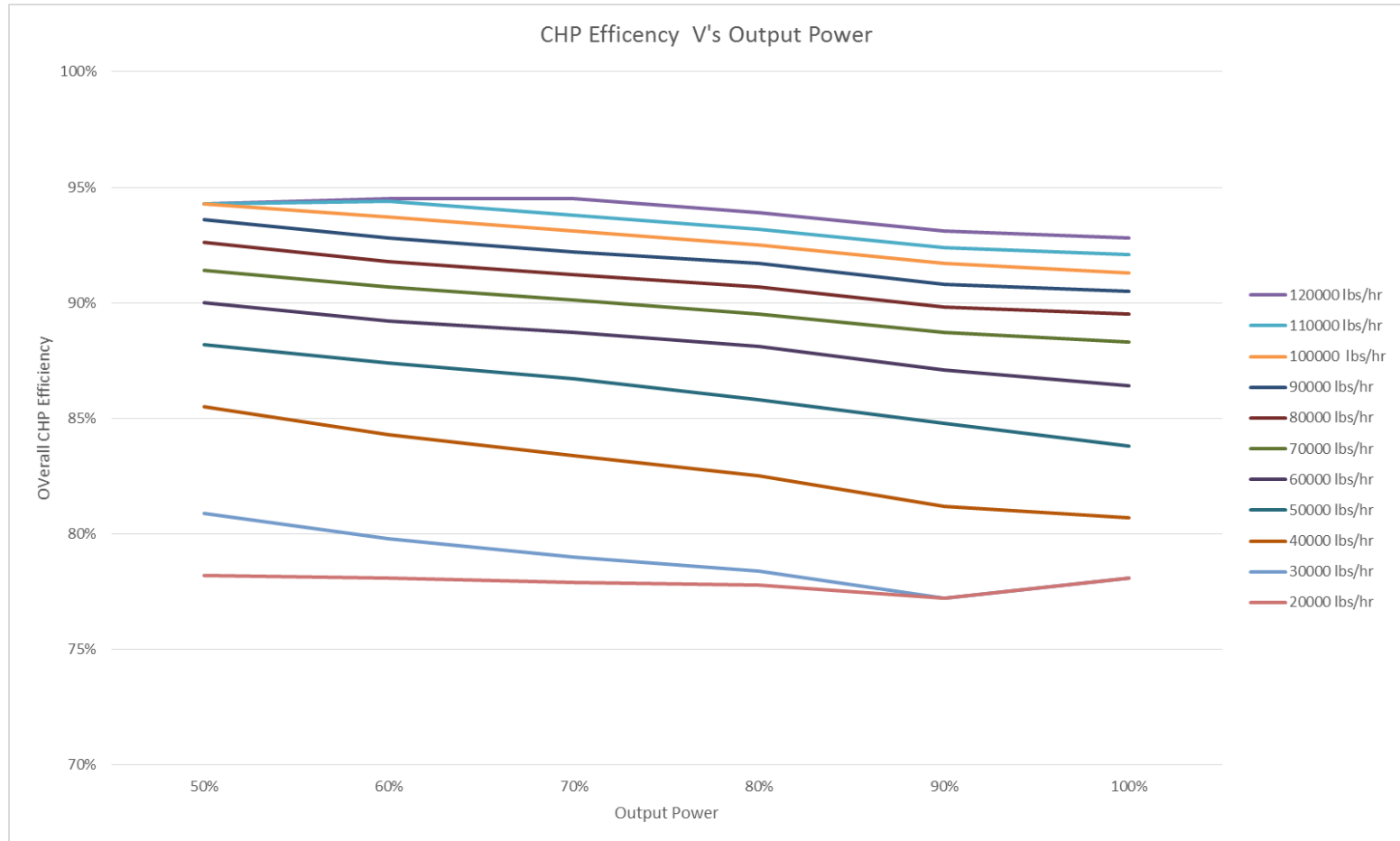
Hundreds evacuating Guinness Storehouse for 'health and safety' reasons

GUINNESS - THE FUTURE

- Reduce GHG emissions from direct operations by 50%
- How to achieve this with significant heat load and demand for resiliency?
 - Introduce Energy Storage
 - Add Resilience
 - Turn off GT
 - Increases system efficiency
 - Purchase of Bio-Gas
 - Installation of Solar Panels

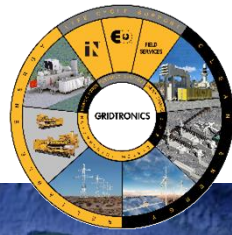


THE EFFICIENCY OF CHP

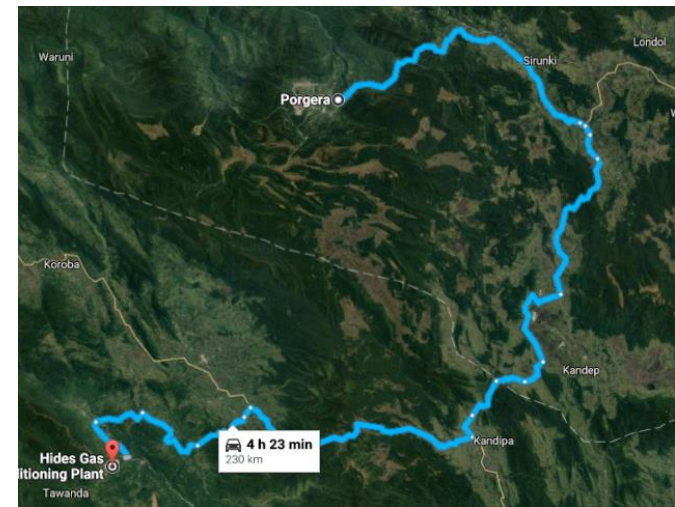


CHP is the perfect solution for ensuring a stable grid with high renewable penetration
40% penetration with no efficiency degradation

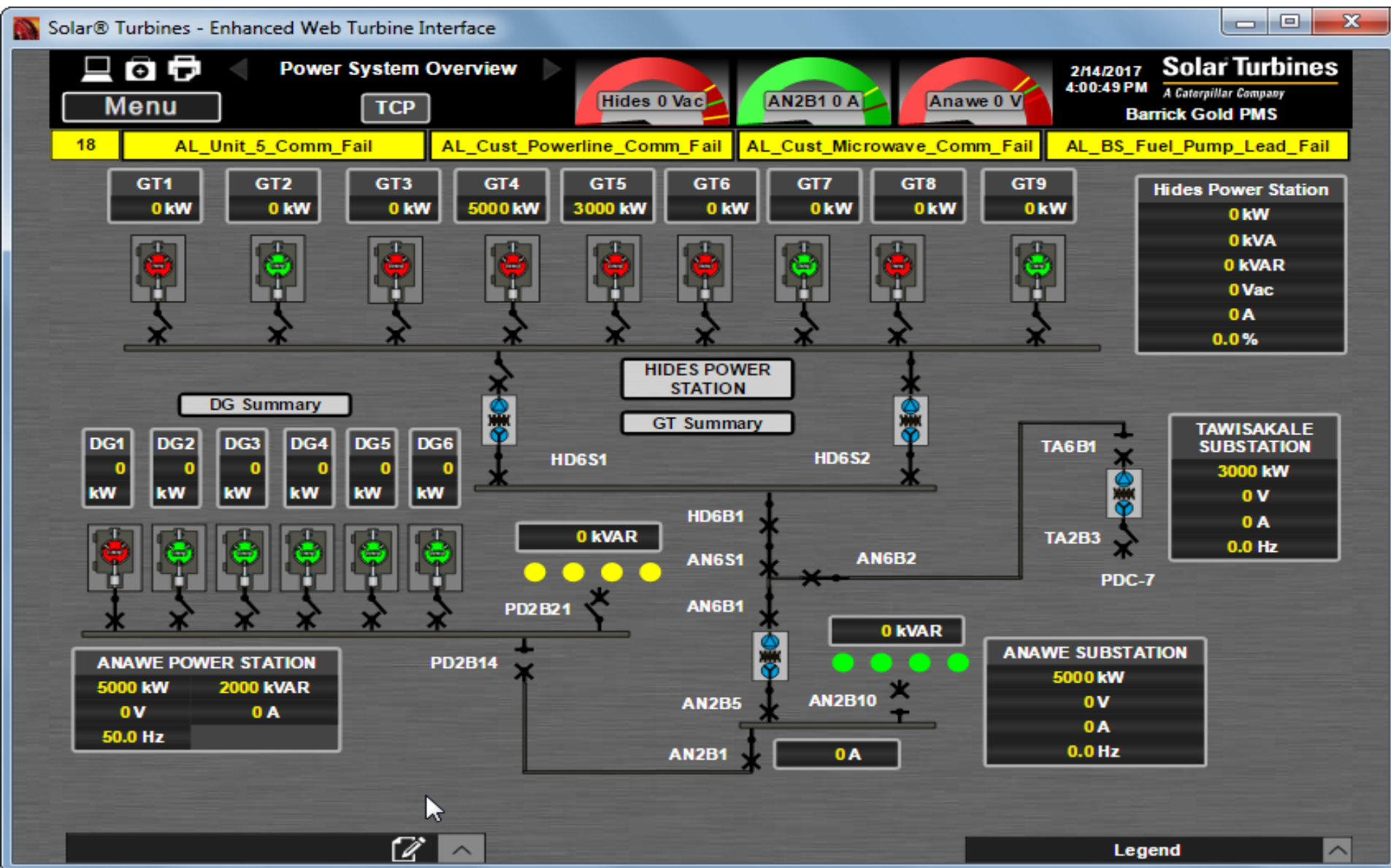
PMS – PAPUA NEW GUINEA



- Two Location Either Side of a Mountain
 - Two Grids
 - 9 GT Generators, 62 MW
 - 6 Diesel Generators, 13 MW
 - 4 Buses
 - 72 km HV line
- Synchronization
 - Genset to Bus
 - Bus to Bus
 - Dead Bus Close
- Load Shedding Scheme
 - Spinning Reserve, Temperature, loss of generation
 - Operates in a scan cycle



POWER SYSTEM OVERVIEW SCREEN



LOAD SHEDDING TRIGGERS



Solar® Turbines - Enhanced Web Turbine Interface

Load Shed Set Points

Menu

TCP

Hides 0 Vac

AN2B1 0 A

Anawe 0 V

2/14/2017 4:04:55 PM

Solar Turbines
A Caterpillar Company
Barick Gold PMS

18

AL_Unit_5_Comm_Fail

AL_Cust_Powerline_Comm_Fail

AL_Cust_Microwave_Comm_Fail

AL_BS_Fuel_Pump_Lead_Fail

	Set Points			
	Trigger 1	Trigger 2	Trigger 3	Trigger 4
Frequency	99 %	98 %	95 %	99 %
Rate of Change	25.0 %/s	25.0 %/s	25.0 %/s	-10.0 %/s
Reserve	8000 kW	8000 kW	8000 kW	2500 kW
Time Delay	10 s	1 s	0 s	0 s
Load to Shed	500 kW	500 kW	1000 kW	1000 kW

System Configuration	
Number Of Loads Hardwired	0.0
Number Of Loads Network	20.0
Number Of Units	9.0
Reserve	0 kW
Frequency	0.0 %

Low Reserve Load Shedding			
	Trigger 1	Trigger 2	Trigger 3
Reserve	200 kW	100 kW	50 kW
Time Delay	120 s	10 s	1 s

Loss of Generator	
Reserve	250 kW

Spinning Reserve Alarms		
	Low	High
Reserve	400 kW	4000 kW
Time Delay	60 s	3600 s

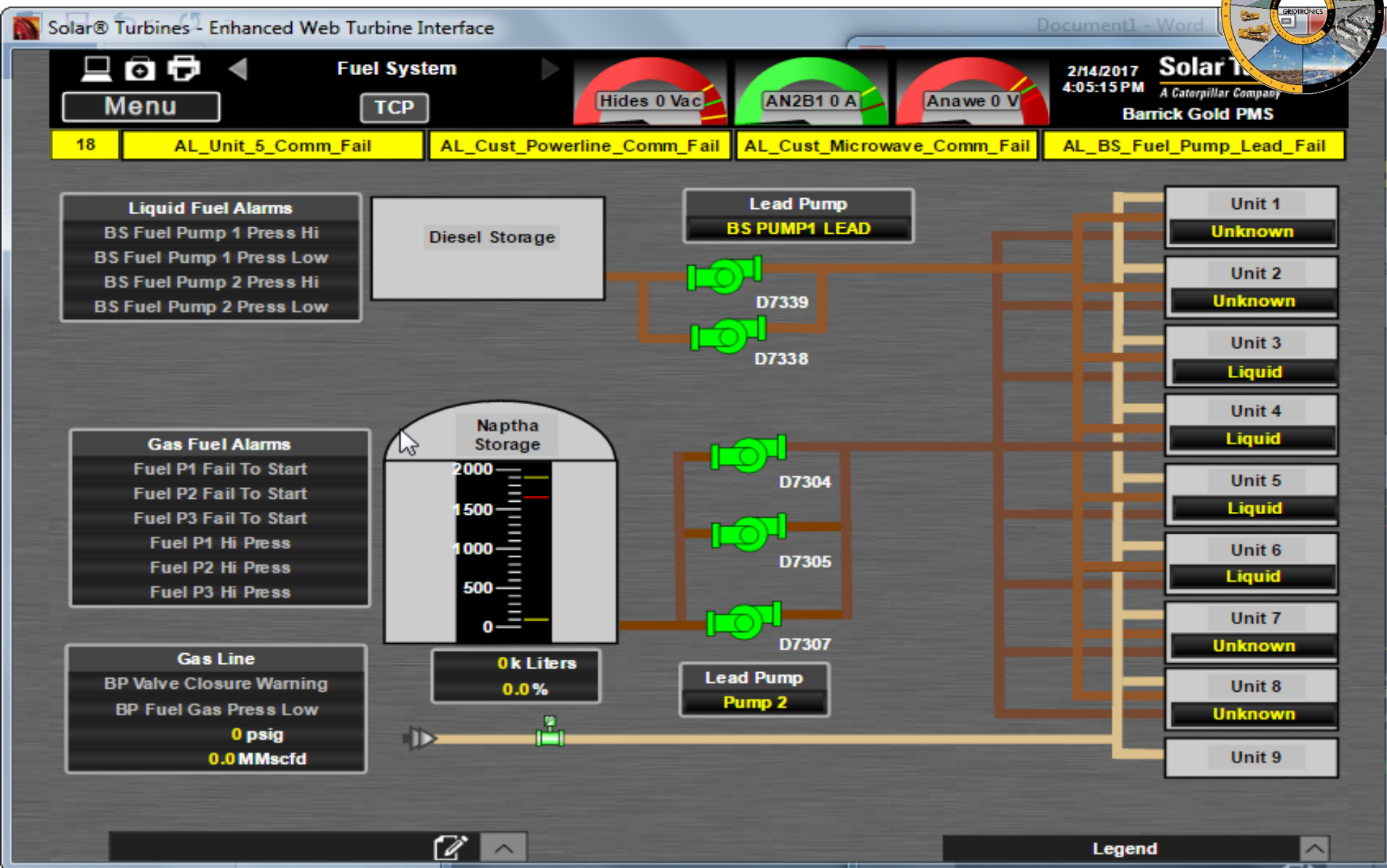
Portgera Low Voltage Set Points	
Low Voltage SP	0 V
Reserve	600 kW
Time Delay	12 s

Large Load Permissives	
Large Load Permissive Timer	120 s

	High Temperature Load Shedding								
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
Load to Shed	900 kW	900 kW	900 kW	900 kW	900 kW	900 kW	900 kW	900 kW	1000 kW

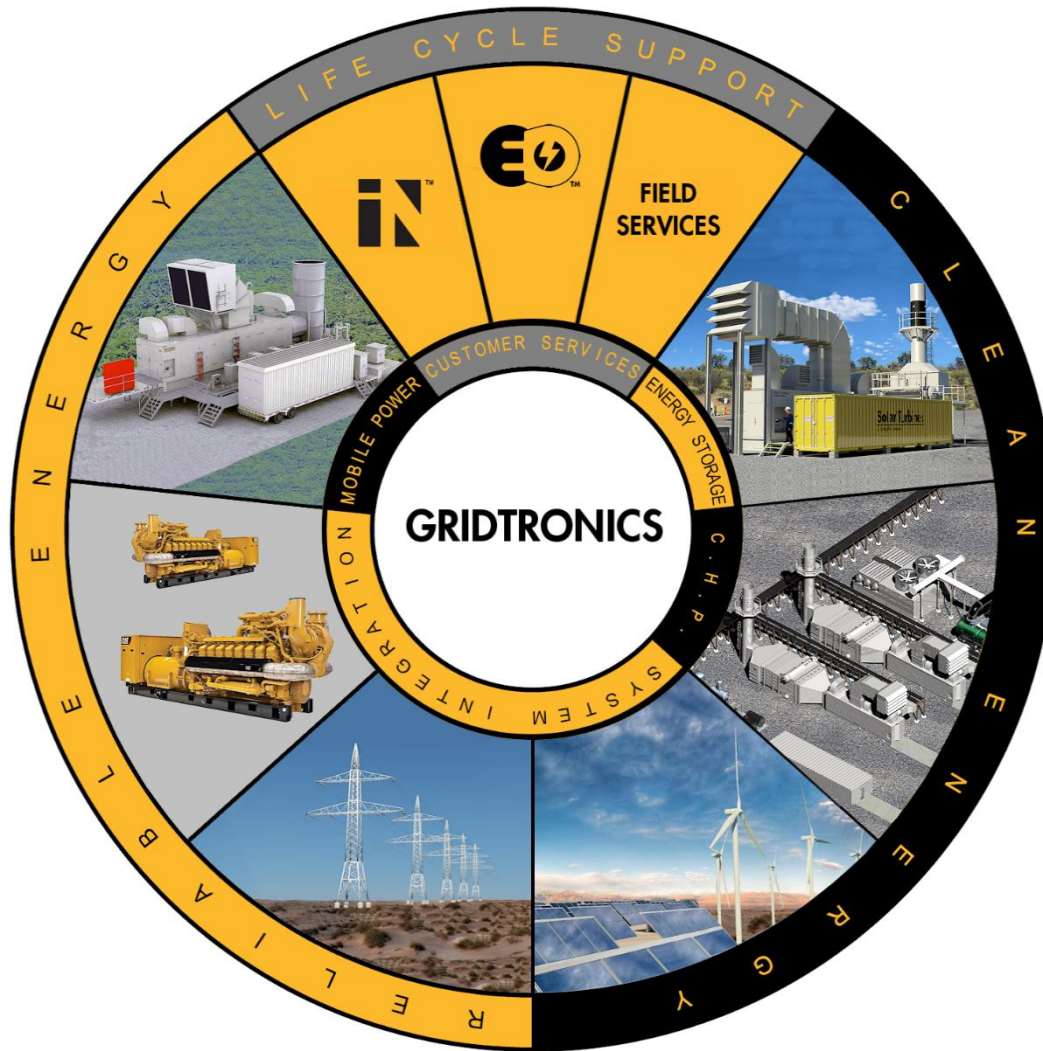


FUEL SYSTEM MONITORING



STATS ON THE MICROGRID





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